EtherCAT Network Adaptor

NA-9186

(EtherCAT)

User Manual

Version 1.02

2013 CREVIS Co.,Ltd

DOCUMENT CHANGE SUMMARY				
REV	PAGE	REMARKS	DATE	EDITOR
1.0	New Document		2012/08/20	JE Kang
1.01	10 25	Add Error LED Add "IO Guide Link Test"	2012/11/22	JE Kang
1.02	6	Add Certification	2013/2/14	JE Kang
		Changed Crevis TEL	2013/4/4	JE KANG

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1. Important Notes

Solid state equipment has operational characteristics differing from those of electromechanical equipment.
Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls describes some important differences between solid state equipment and hard-wired electromechanical devices.
Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will CREVIS be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.
The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, CREVIS cannot assume responsibility or liability for actual use based on the examples and diagrams.

Warning!

- ✓ **If you don't follow the directions, it could cause a personal injury, damage to the equipment or explosion**
- Do not assemble the products and wire with power applied to the system. Else it may cause an electric arc, which can result into unexpected and potentially dangerous action by field devices. Arching is explosion risk in hazardous locations. Be sure that the area is non-hazardous or remove system power appropriately before assembling or wiring the modules.
- Do not touch any terminal blocks or IO modules when system is running. Else it may cause the unit to an electric shock or malfunction.
- Keep away from the strange metallic materials not related to the unit and wiring works should be controlled by the electric expert engineer. Else it may cause the unit to a fire, electric shock or malfunction.

Caution!

- ✓ **If you disobey the instructions, there may be possibility of personal injury, damage to equipment or explosion. Please follow below Instructions.**
- Check the rated voltage and terminal array before wiring. Avoid the circumstances over 55℃ of temperature. Avoid placing it directly in the sunlight.
- Avoid the place under circumstances over 85% of humidity.
- Do not place Modules near by the inflammable material. Else it may cause a fire.
- Do not permit any vibration approaching it directly.
- Go through module specification carefully, ensure inputs, output connections are made with the specifications. Use standard cables for wiring.
- Use Product under pollution degree 2 environment.

1.1. Safety Instruction

1.1.1. Symbols

DANGER	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death property damage or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury, property damage, or economic loss. Attentions help you to identity a hazard, avoid a hazard, and recognize the consequences.

1.1.2. Safety Notes

DANGER	The modules are equipped with electronic components that may be destroyed by electrostatic discharge. When handling the modules, ensure that the environment (persons, workplace and packing) is well grounded. Avoid touching conductive components, e.g. FnBUS Pin.

1.1.3. Certification

c-UL-us UL Listed Industrial Control Equipment, certified for U.S. and Canada
See UL File E235505

CE Certificate
EN 61000-6-2; Industrial Immunity
EN 61000-6-4; Industrial Emissions

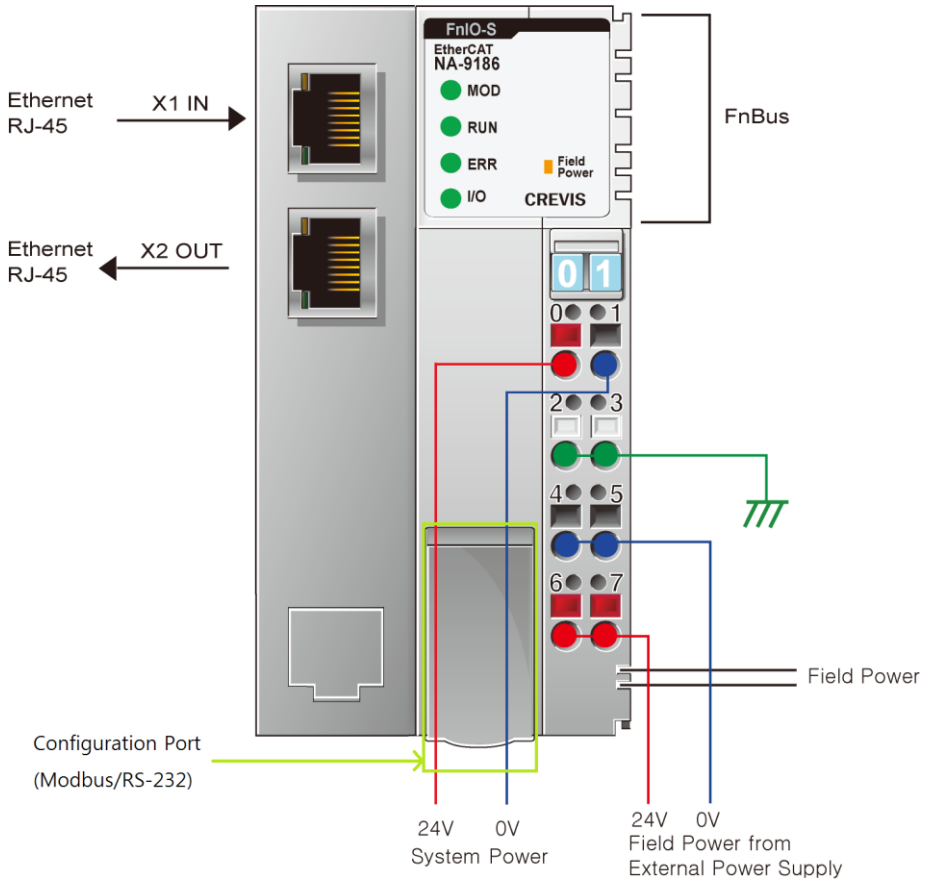
FCC

RoHS (EU, China)

2. Specification

2.1. The Interface

2.1.1. NA-9186 (EtherCAT)



2.2. Specification

2.2.1. General Specification

General Specification	
System Power	Supply voltage : 24Vdc nominal Supply voltage range : 11~28.8Vdc Protection : Output current limit (Min. 1.5A) Reverse polarity protection
Power Dissipation	100mA typical @24Vdc
Current for I/O Module	1.5A @5Vdc
Isolation	System power to internal logic : Non-isolation System power to I/O driver : Isolation System to Physial(RJ-45) : Trans, Isolation
Field Power	Supply voltage : 24Vdc nominal Supply voltage range : 11~28.8Vdc
Max. Current Field Power Contact	DC 10A Max.
Weight	150g
Module Size	54mm x 99mm x 70mm
Environment Condition	Refer to Environment Specification

Environmental Specifications	
Operating Temperature	-20℃ to 55℃
Non-Operating Temperature	-40℃ to 85℃
Relative Humidity	5%~90% non-condensing
Operating Altitude	2000m
Mounting	DIN rail

2.2.2. Interface Specification

Interface Specification, NA-9186 (EtherCAT)			
Adapter Type	EtherCAT Slave Node		
Max. Expansion Module	32 slots		
Max. Input Size	252 bytes (2016 points)		
Max. Output Size	252 bytes (2016 points)		
Data Baud Rate	100Mbps		
Max. Nodes	65,535		
Interface Connector	RJ-45 Socket 2ports (ECAT IN→IN, ECAT OUT→OUT)		
Mac Address / IP Address	No need		
Indicator	5 LEDs (Front Window) - 1 Green/Red, Module Status (MOD) - 1 Green, Current Running Status (RUN) - 1 Green/Red, Error Status (ERR) - 1 Green/Red, Expansion I/O Module Status (I/O) - 1 Green, Field Power Status 2 LEDs (each RJ-45 Connector) - 1 Yellow Link, Active - 1 Green Not used		
Module Location	Starter module – left side of FnIO system		
Field Power Detection	About 11Vdc		
Configuration Tool	IO Guide Pro		
Configuration Port	Modbus/RS-232	Node	1 (fixed)
		Baud rate	115200 (fixed)
		Data bit	8 (fixed)
		Parity bit	No parity (fixed)
		Stop bit	1 (fixed)
		Connector Cable Type	3M mini Clamp Plug (371 series) - Modbus RS232 IN ➔ IN RS232 Serial Connector - Opposite direction

2.3. LED Indicator

2.3.1. Module Status LED (MOD)

State	LED is :	To indicate :
No Power	Off	No power is supplied to the unit.
Device Operational	Green	The unit is operating in normal condition.
Device in Standby	Flashing Green	The EEPROM parameter is not initialized yet. Serial Number is zero value (0x00000000)
Minor Fault	Flashing Red	The unit has occurred recoverable fault in self-testing. - EEPROM checksum fault
Unrecoverable Fault	Red	The unit has occurred unrecoverable fault in self-testing. - Firmware fault

2.3.2. Current Running Status LED (RUN)

State	LED is :	To indicate :
Init	Off	State of the EtherCAT State Machine: INIT = Initialization
Pre-Operational	Blinking	State of the EtherCAT State Machine: PREOP = Pre-Operational
Safe-Operational	Single Flash	State of the EtherCAT State Machine: SAFEOP = Safe-Operational
Initialization or Bootstrap	Flashes	State of the EtherCAT State Machine: BOOT = Bootstrap (Update of the coupler firmware)
Operational	On	State of the EtherCAT State Machine: OP = Operational

2.3.3. Error Status LED (ERR)

State	LED is :	To indicate :
No Error	Off	No Error
Invalid Configuration	Blinking	Invalid Configuration
Unsolicited State Change	Single Flash	Local Error
Application Watchdog Timeout	Double Flash	Process Data Watchdog Timeout / EtherCAT Watchdog Timeout
Booting Error	Flashes	Booting Error
PDI Watchdog Timeout	On	Application Controller Failure

2.3.4. Expansion Module Status LED (I/O)

State	LED is :	To indicate :
Not Powered No Expansion Module	Off	Device has no expansion module or may not be powered
FnBus On-line, Do not Exchanging I/O	Flashing Green	FnBus is normal but does not exchanging I/O data (Passed the expansion module configuration).
FnBus Connection, Run Exchanging IO	Green	Exchanging I/O data
FnBus connection fault during exchanging IO	Red	One or more expansion module occurred in fault state. - Changed expansion module configuration. - FnBus communication failure.
Expansion Configuration Failed	Flashing Red	Failed to initialize expansion module - Detected invalid expansion module ID. - Overflowed Input / Output Size - Too many expansion module - Initial protocol failure - Mismatch vendor code between adapter and expansion module.

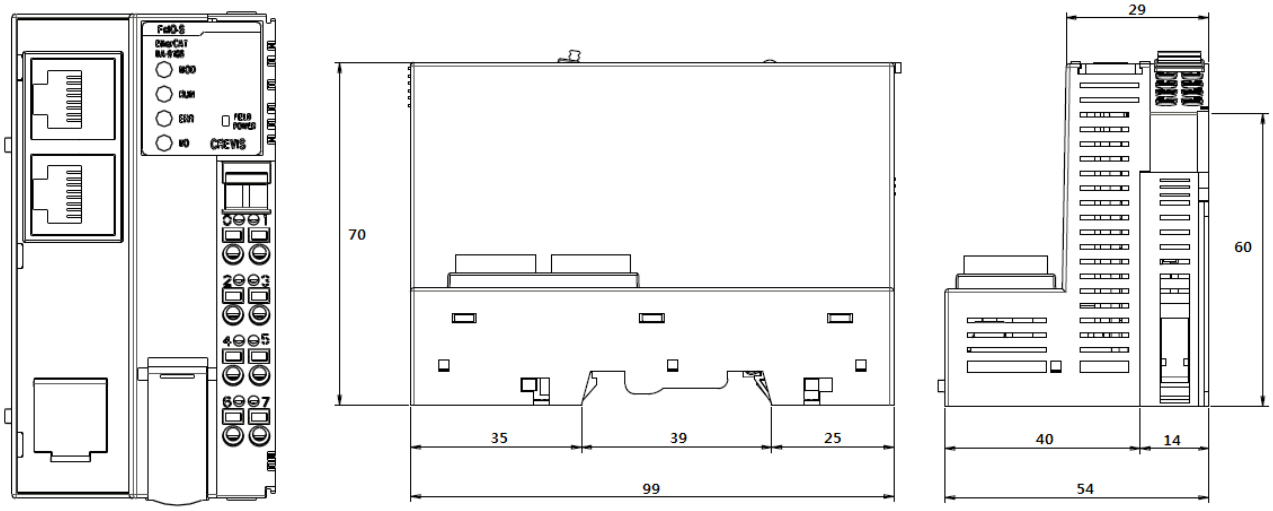
2.3.5. Field Power Status LED

State	LED is :	To indicate :
Not Supplied Field Power	Off	Not supplied 24V dc field power
Supplied Field Power	Green	Supplied 24V dc field power

3. Dimension

3.1. NA-9186

(mm)



4. Mechanical Setup

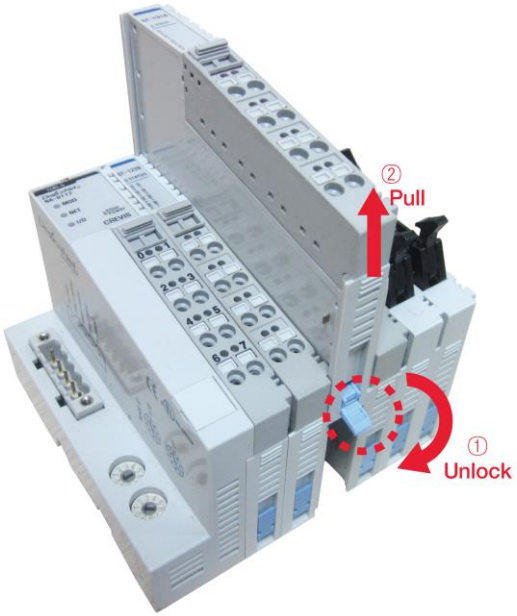
4.1. Total Expansion

The number of the module assembly that can be connected is 32. So the maximum length is 426mm Exception. ST-2748 is excepted to calculate maximum length because that is double width module.

4.2. Plugging and Removal of the Components.

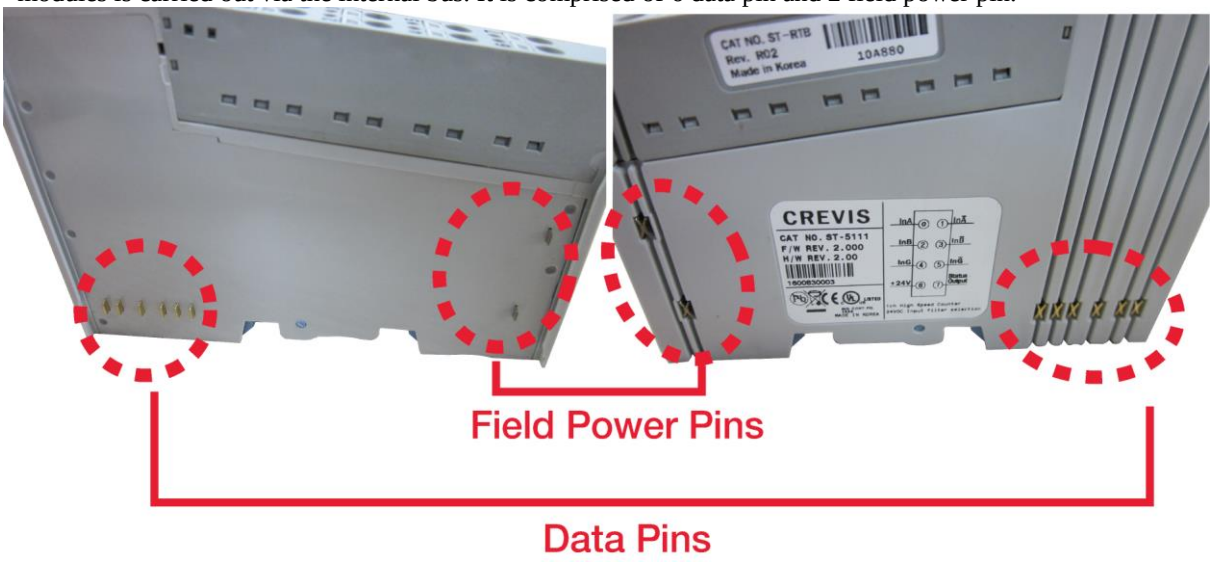
DANGER	Before work is done on the components, the voltage supply must be turned off.

As above figure in order to safeguard the FnIO module from jamming, it should be fixed onto the DIN rail with locking level. To do so, fold on the upper of the locking lever.
To pull out the FnIO module, unfold the locking lever as below figure.



4.3. Internal FnBus/Field Power Contacts

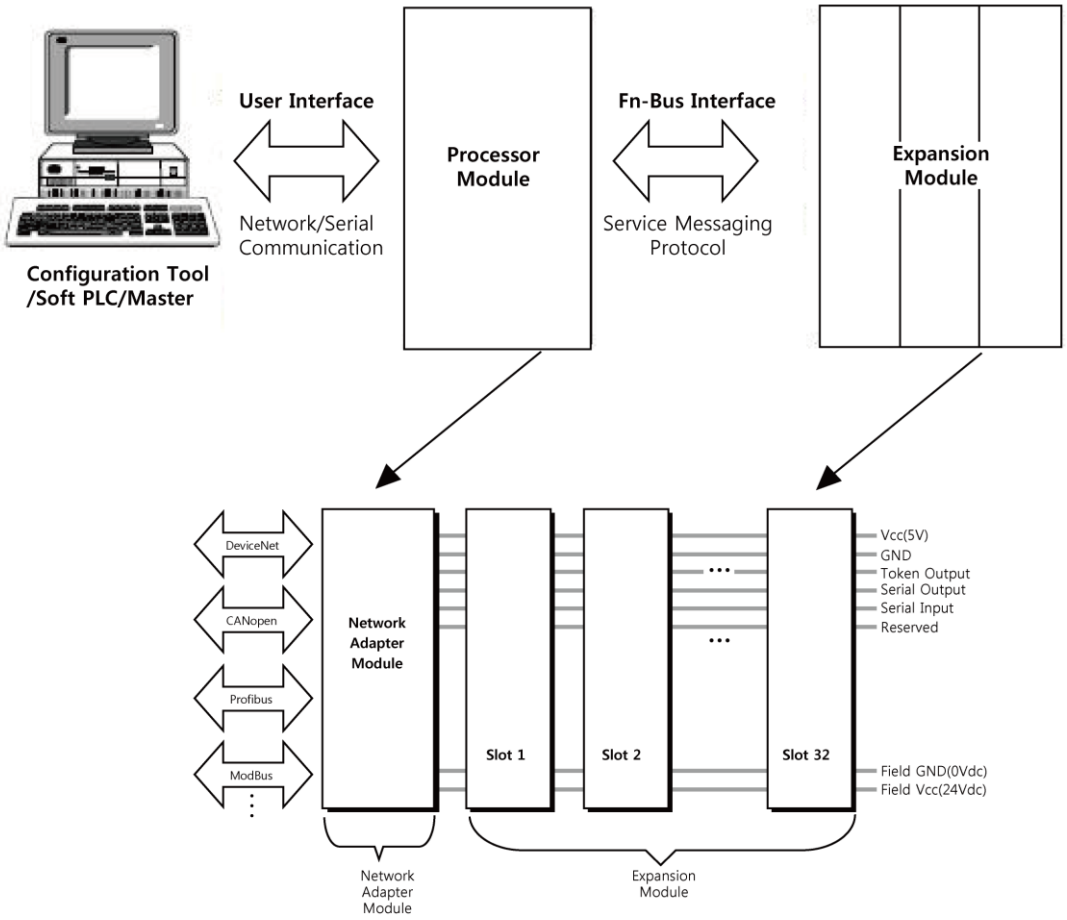
Communication between the NA series and the expansion module as well as system / field power supply of the bus modules is carried out via the internal bus. It is comprised of 6 data pin and 2 field power pin.



DANGER	Do not touch data and field power pins in order to avoid soiling and damage by ESD noise.

5. MODBUS Electrical Interface

5.1. FnBus System



• Network Adapter Module

The Network Adapter Module forms the link between the field bus and the field devices with the Expansion Modules.

The connection to different field bus systems can be established by each of the corresponding Network Adapter Module, e.g. for SyncNet, PROFIBUS, CANopen, DeviceNet, Ethernet/IP, EtherCAT, CC-Link, MODBUS/Serial, MODBUS/TCP etc.

• Expansion Module

The Expansion Modules are supported a variety of input and output field devices.
There are digital and analog input/output modules and special function modules.

• Two types of FnBus Message

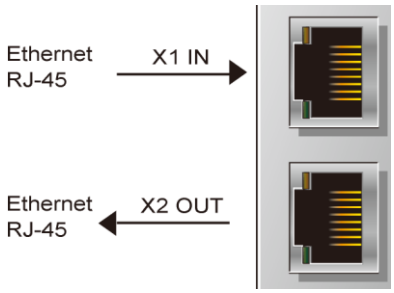
- Service Messaging
- I/O Messaging

FnBus Pin Description

No.	Name	Description
1	Vcc	System supply voltage (5V dc).
2	GND	System Ground.
3	Token Output	Token output port of Processor module.
4	Serial Output	Transmitter output port of Processor module.
5	Serial Input	Receiver input port of Processor module.
6	Reserved	Reserved for bypass Token.
7	Field GND	Field Ground.
8	Field Vcc	Field supply voltage (24Vdc).

5.2. EtherCAT Electrical Interface

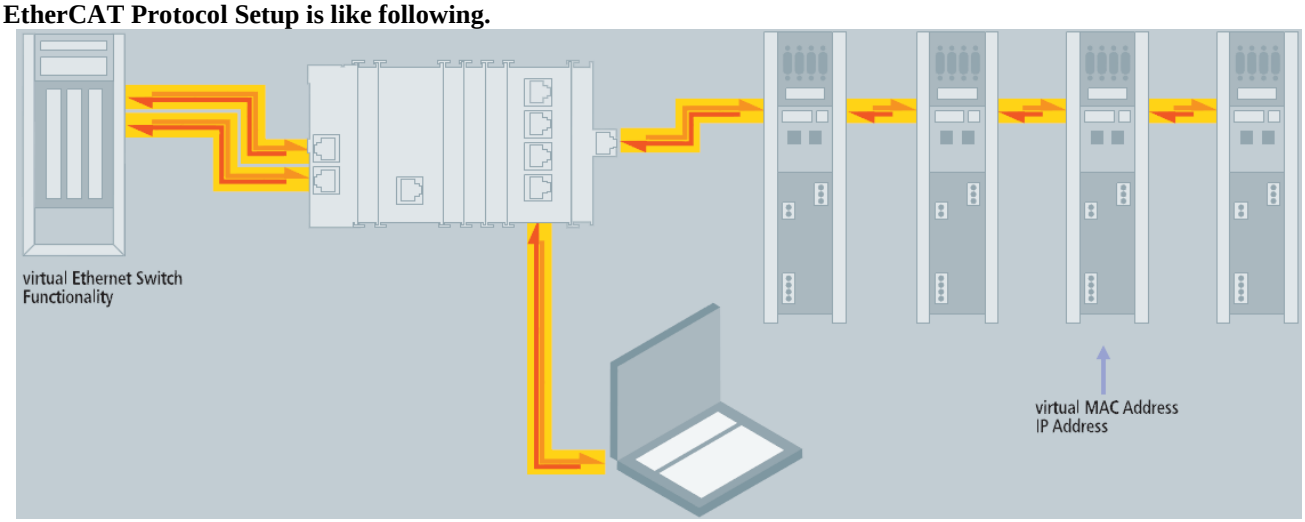
5.2.1. NA-9186 RJ-45 Socket



Shielded RJ-45 Socket

RJ-45	Signal Name	Description
1	TD+	Transmit +
2	TD-	Transmit -
3	RD+	Receive +
4	-	
5	-	
6	RD-	Receive -
7	-	
8	-	
Case	Shield	

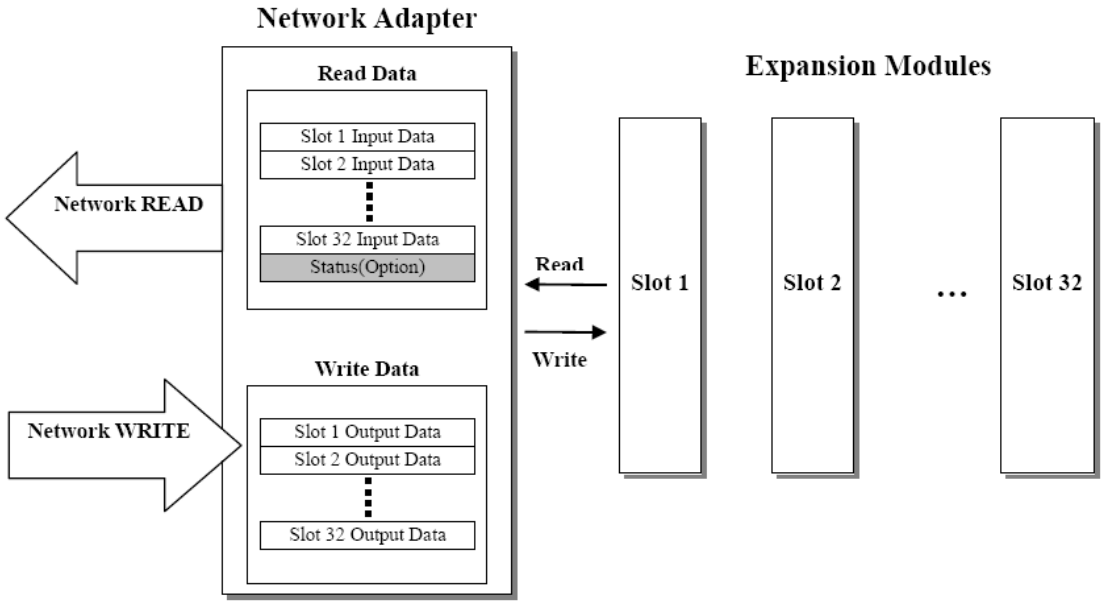
EtherCAT Protocol Setup is like following.



ATTENTION	The use of an incorrect supply voltage or frequency can cause severe damage to the component.

5.2.2. I/O Process Image Map

An expansion module may have 3 types of data as I/O data, configuration parameter and memory register. The data exchange between network adapter and expansion modules is done via an I/O process image data by FnBus protocol. The following figure shows the data flow of process image between network adapter and expansion modules.

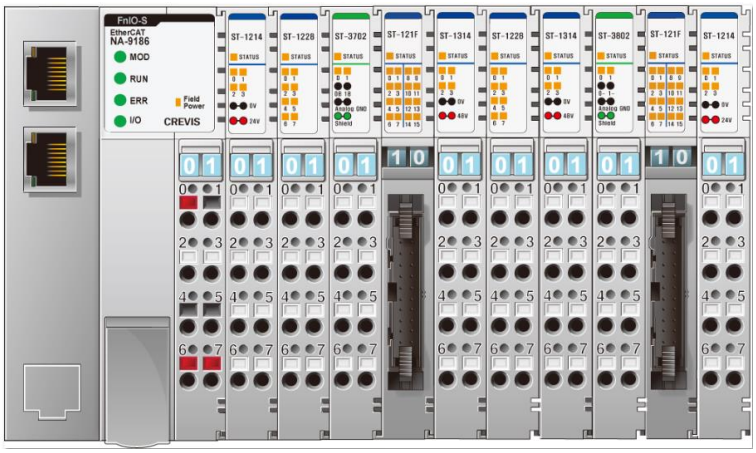


5.3. Example

5.3.1. Example of Input Process Image(Input Register) Map

Input image data depends on slot position and expansion slot data type. Input process image data is only ordered by expansion slot position.

- **For example slot configuration**



Slot Address	Module Description
#0	EtherCAT Adapter
#1	4-discrete input
#2	8-discrete input
#3	2-analog input
#4	16-discrete input
#5	4-discrete input
#6	8-discrete input
#7	4-discrete input
#8	2-analog input
#9	16-discrete input
#10	4-discrete input

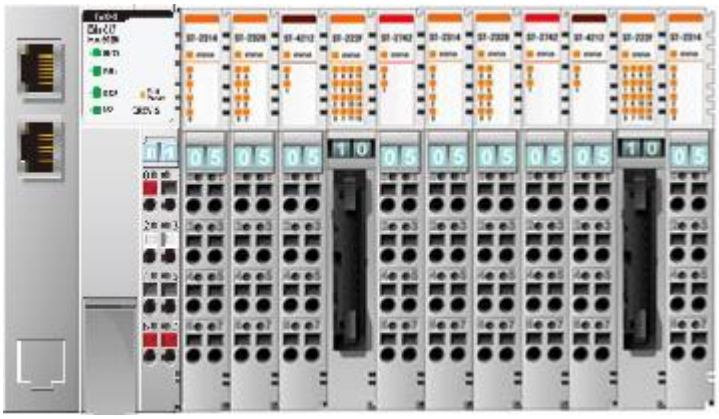
- **Input Process Image**

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte #0	Empty, Always 0				Discrete Input 4 pts (Slot#1)			
Byte #1	Discrete Input 8 pts (Slot#2)							
Byte #2	Analog Input Ch0 low byte (Slot#3)							
Byte #3	Analog Input Ch0 high byte (Slot#3)							
Byte #4	Analog Input Ch1 low byte (Slot#3)							
Byte #5	Analog Input Ch1 high byte (Slot#3)							
Byte #6	Discrete Input low 8 pts (Slot#4)							
Byte #7	Discrete Input high 8 pts (Slot#4)							
Byte #8	Empty, Always 0				Discrete Input 4 pts (Slot#5)			
Byte #9	Discrete Input 8 pts (Slot#6)							
Byte #10	Empty, Always 0				Discrete Input 4 pts (Slot#7)			
Byte #11	Analog Input Ch0 low byte (Slot#8)							
Byte #12	Analog Input Ch0 high byte (Slot#8)							
Byte #13	Analog Input Ch1 low byte (Slot#8)							
Byte #14	Analog Input Ch1 high byte (Slot#8)							
Byte #15	Discrete Input low 8 pts (Slot#9)							
Byte #16	Discrete Input high 8 pts (Slot#9)							
Byte #17	Empty, Always 0				Discrete Input 4 pts (Slot#10)			

5.3.2. Example of Output Process Image(Output Register) Map

Output image data depends on slot position and expansion slot data type. Output process image data is only ordered by expansion slot.

- **For example slot configuration**



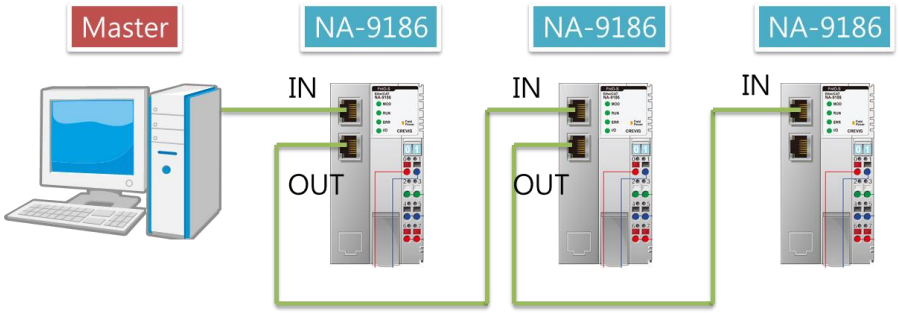
Slot Address	Module Description
#0	EtherCAT Adapter
#1	4-discrete output
#2	8-discrete output
#3	2-analog output
#4	16-discrete output
#5	4-discrete output
#6	8-discrete output
#7	2-relay output
#8	2-relay output
#9	2-analog output
#10	16-discrete output
#11	4-discrete output

- **Output Process Image**

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte #0	Empty, Don't care				Discrete Output 4 pts (Slot#1)			
Byte #1	Discrete Output 8 pts (Slot#2)							
Byte #2	Analog Output Ch0 low byte (Slot#3)							
Byte #3	Analog Output Ch0 high byte (Slot#3)							
Byte #4	Analog Output Ch1 low byte (Slot#3)							
Byte #5	Analog Output Ch1 high byte (Slot#3)							
Byte #6	Discrete Output low 8 pts (Slot#4)							
Byte #7	Discrete Output high 8 pts (Slot#4)							
Byte #8	Empty, Don't care				Discrete Output 4 pts (Slot#5)			
Byte #9	Discrete Input 8 pts (Slot#6)							
Byte #10	Empty, Don't care							Discrete Output 2 pts (Slot#7)
Byte #11	Empty, Don't care							Discrete Output 2 pts (Slot#8)
Byte #12	Analog Output Ch0 low byte (Slot#9)							
Byte #13	Analog Output Ch0 high byte (Slot#9)							
Byte #14	Analog Output Ch1 low byte (Slot#9)							
Byte #15	Analog Output Ch1 high byte (Slot#9)							
Byte #16	Discrete Output low 8 pts (Slot#10)							
Byte #17	Discrete Output high 8 pts (Slot#10)							
Byte #18	Empty, Don't care				Discrete Output 4 pts (Slot#11)			

5.4. How to use the NA-9186

- **How to connect the master and slave**

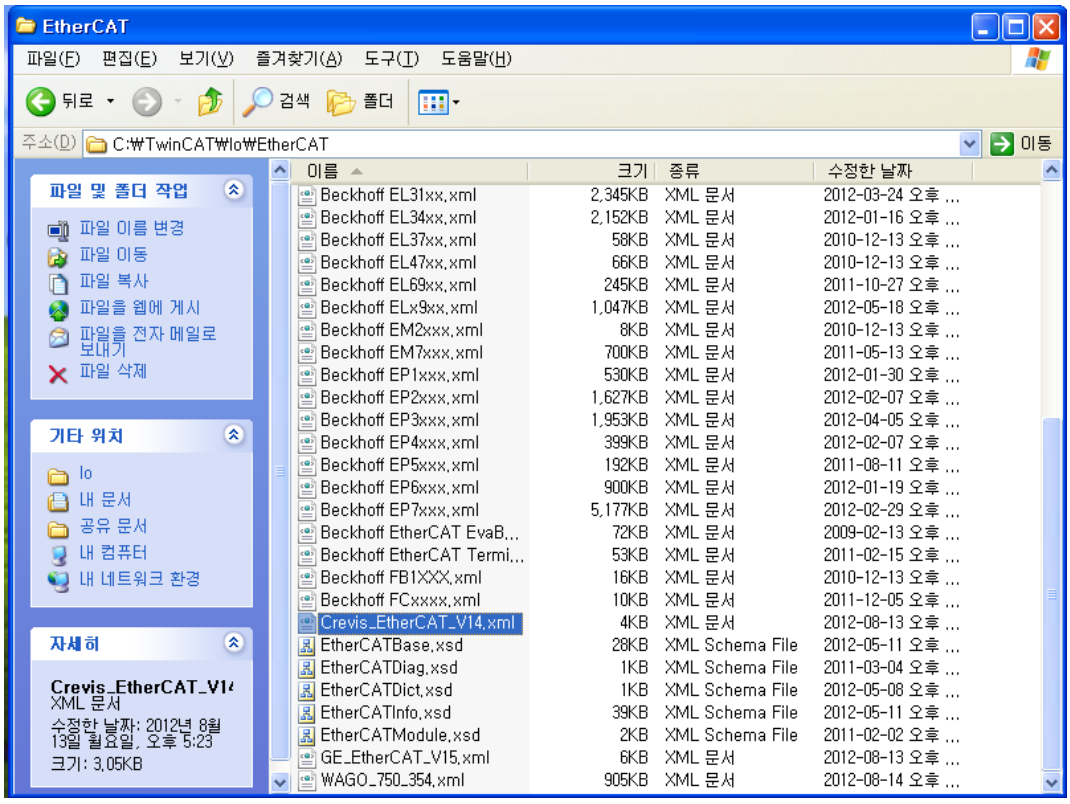


When you connect multiple nodes, using the IN/OUT port is connected.
IO Size and Node Address is determined sequentially from the closest thing to master.

5.4.1. The Procedure of Configuration with Tools

➢ **TwinCAT**

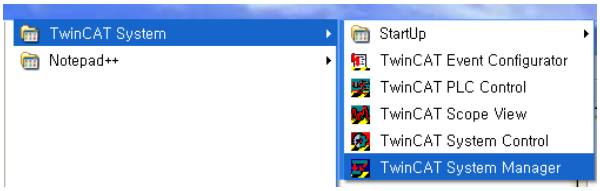
- **Setup XML file**


EtherCAT
파일(F) 편집(E) 보기(V) 즐겨찾기(A) 도구(T) 도움말(H)
뒤로 검색 폴더
주소(D) C:₩TwinCAT₩Io₩EtherCAT
이동
파일 및 폴더 작업
파일 이름 변경
파일 이동
파일 복사
파일을 웹에 게시
파일을 전자 메일로 보내기
파일 삭제
기타 위치
Io
내 문서
공유 문서
내 컴퓨터
내 네트워크 환경
자세히
Crevis_EtherCAT_V14
XML 문서
수정한 날짜: 2012년 8월 13일 월요일, 오후 5:23
크기: 3.05KB
이름 크기 종류 수정한 날짜
Beckhoff EL31xx.xml 2,345KB XML 문서 2012-03-24 오후 ...
Beckhoff EL34xx.xml 2,152KB XML 문서 2012-01-16 오후 ...
Beckhoff EL37xx.xml 58KB XML 문서 2010-12-13 오후 ...
Beckhoff EL47xx.xml 66KB XML 문서 2010-12-13 오후 ...
Beckhoff EL69xx.xml 245KB XML 문서 2011-10-27 오후 ...
Beckhoff ELx9xx.xml 1,047KB XML 문서 2012-05-18 오후 ...
Beckhoff EM2xxx.xml 8KB XML 문서 2010-12-13 오후 ...
Beckhoff EM7xxx.xml 700KB XML 문서 2011-05-13 오후 ...
Beckhoff EP1xxx.xml 530KB XML 문서 2012-01-30 오후 ...
Beckhoff EP2xxx.xml 1,627KB XML 문서 2012-02-07 오후 ...
Beckhoff EP3xxx.xml 1,953KB XML 문서 2012-04-05 오후 ...
Beckhoff EP4xxx.xml 399KB XML 문서 2012-02-07 오후 ...
Beckhoff EP5xxx.xml 192KB XML 문서 2011-08-11 오후 ...
Beckhoff EP6xxx.xml 900KB XML 문서 2012-01-19 오후 ...
Beckhoff EP7xxx.xml 5,177KB XML 문서 2012-02-29 오후 ...
Beckhoff EtherCAT EvaB... 72KB XML 문서 2009-02-13 오후 ...
Beckhoff EtherCAT Termi... 53KB XML 문서 2011-02-15 오후 ...
Beckhoff FB1XXX.xml 16KB XML 문서 2010-12-13 오후 ...
Beckhoff FCxxxx.xml 10KB XML 문서 2011-12-05 오후 ...
Crevis_EtherCAT_V14.xml 4KB XML 문서 2012-08-13 오후 ...
EtherCATBase.xsd 28KB XML Schema File 2012-05-11 오후 ...
EtherCATDiag.xsd 1KB XML Schema File 2011-03-04 오후 ...
EtherCATDict.xsd 1KB XML Schema File 2012-05-08 오후 ...
EtherCATInfo.xsd 39KB XML Schema File 2012-05-11 오후 ...
EtherCATModule.xsd 2KB XML Schema File 2011-02-02 오후 ...
GE_EtherCAT_V15.xml 6KB XML 문서 2012-08-13 오후 ...
WAGO_750_354.xml 905KB XML 문서 2012-08-14 오후 ...

"C:\TwinCAT\IO\EtherCAT" : Location of the XML file
Please copy the XML file to that folder.

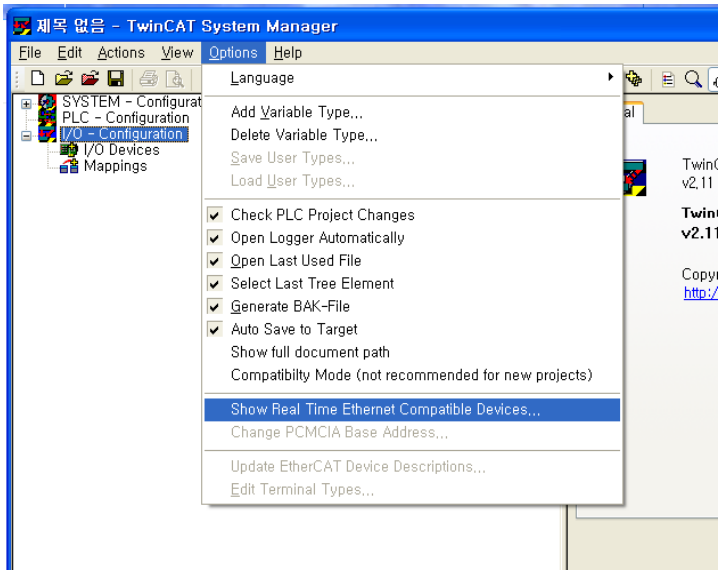
- **Configuration method**

① Program execution

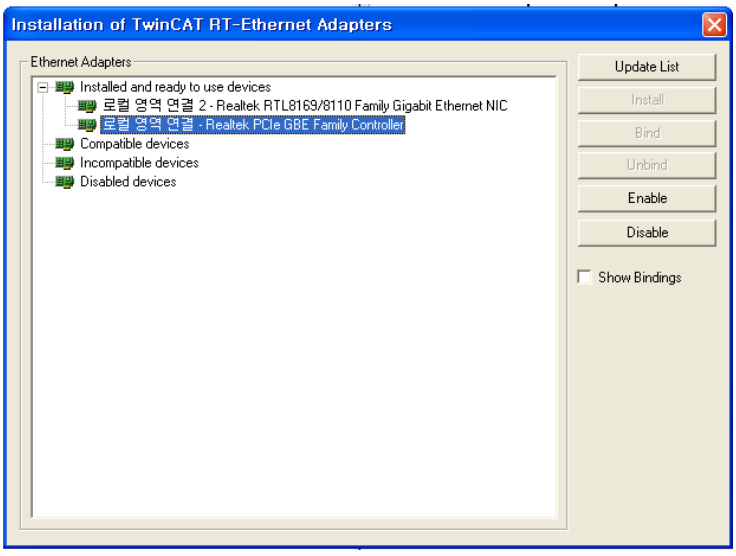


② Setup Ethernet port

A. ‘Options’ → ‘Show Real Time Ethernet Compatible Devices…’

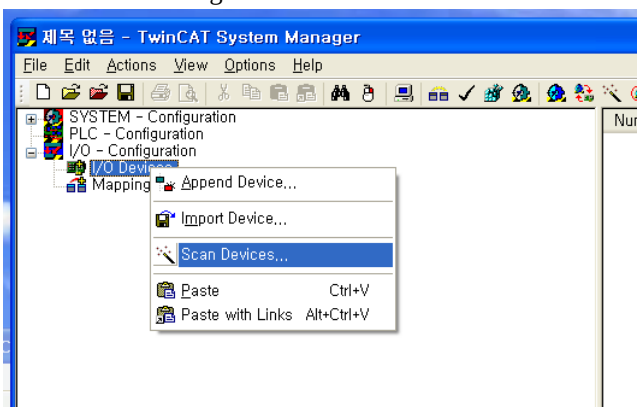


B. ‘Installation of TwinCAT RT-Ethernet Adapter’ window, the LAN card enable.

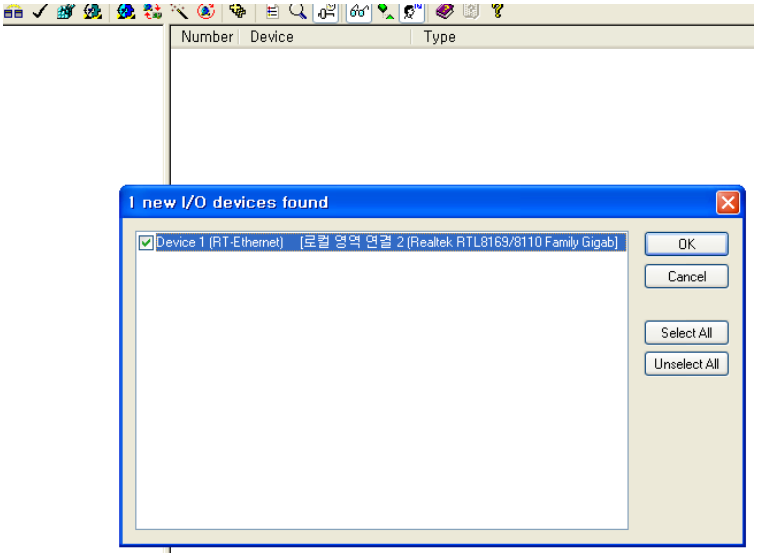


③ IO Configuration

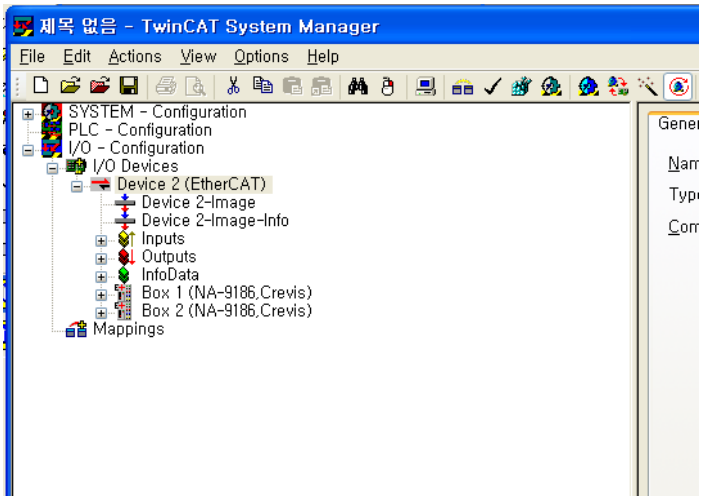
A. IO Devices ‘right click’ and select ‘Scan Devices…’



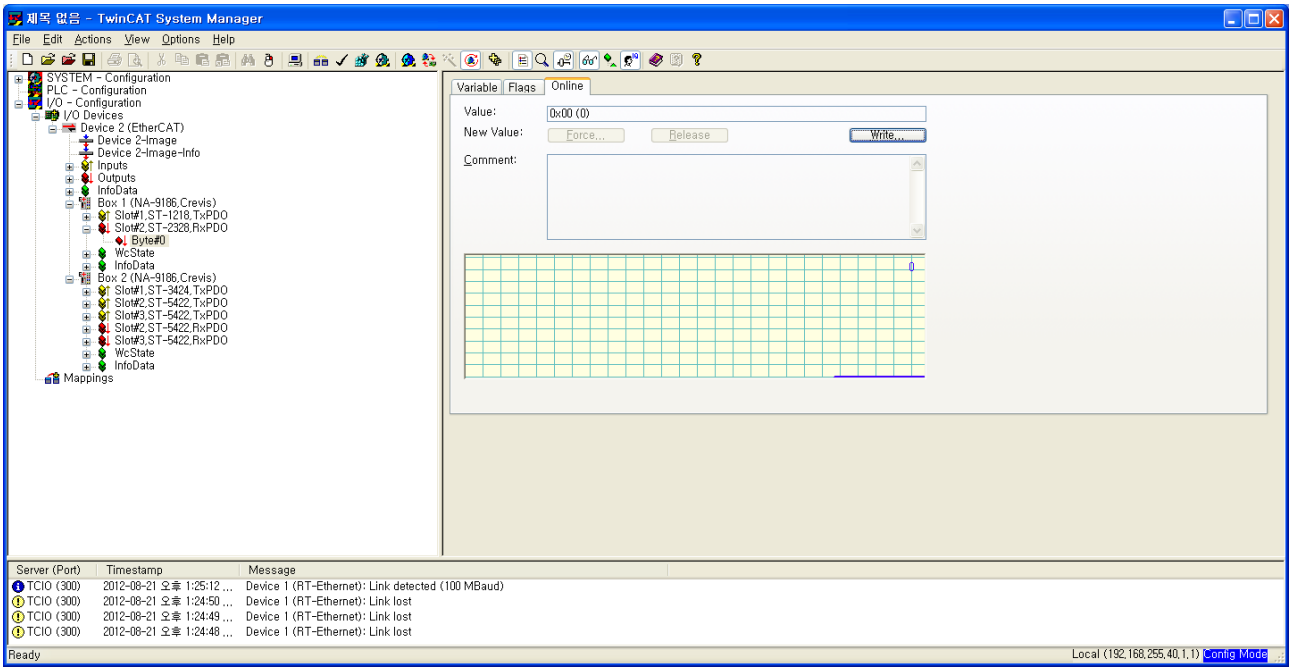
B. Select LAN CARD and OK click.



④ Device is created.



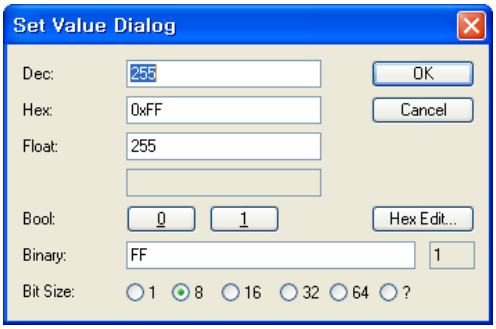
⑤ Finish



Determine whether the connection by sending output value.

Output value can be entered in the following manner.

- Export the output node of the IO
- Output Byte Select
- 'Write' button of 'Online' window clicked



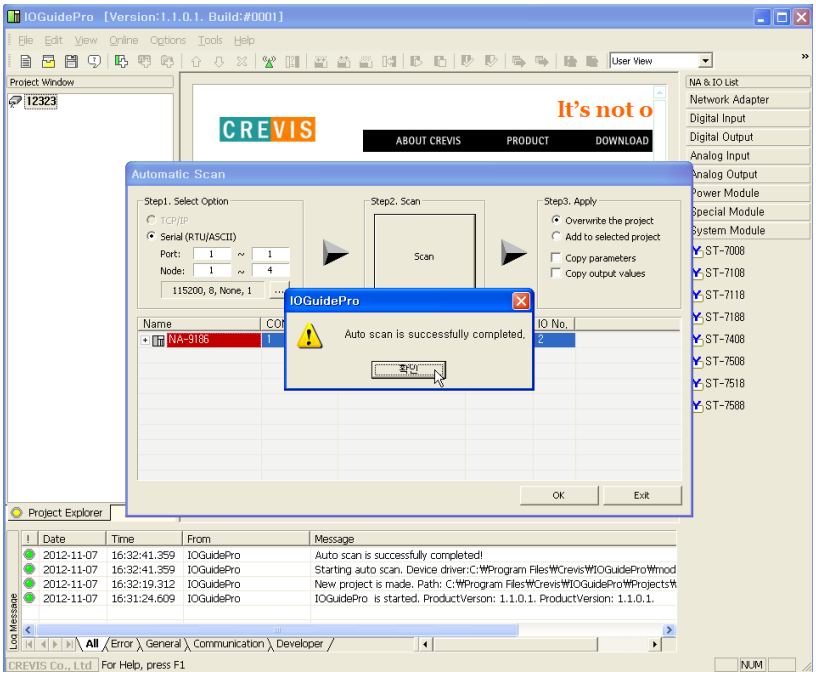
- Set value

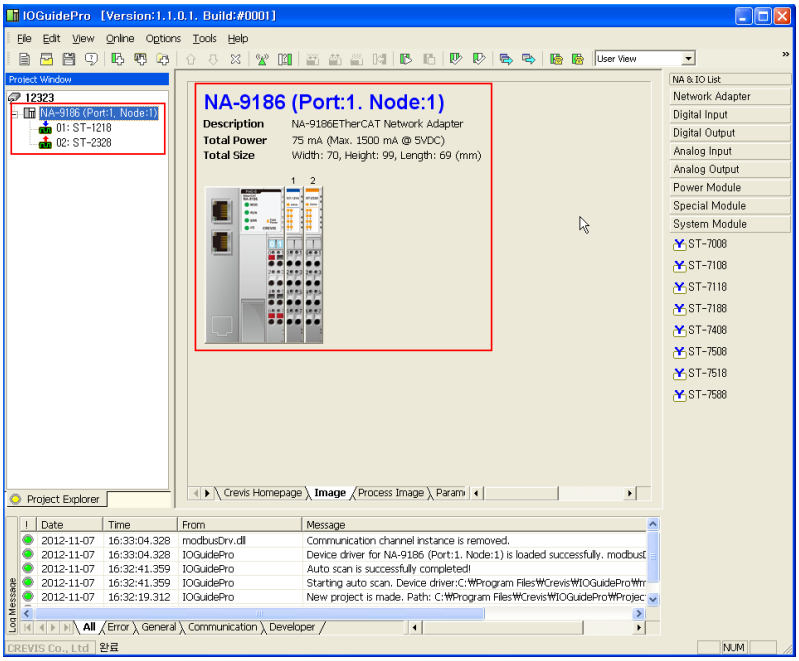
5.4.2. IO Guide Link Test (Communication with IO Guide)

- **Test method**

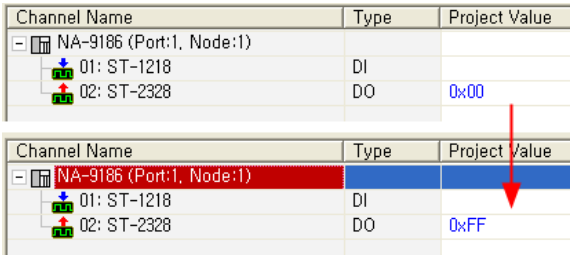
Verify communication success with IO Guide.

① To use “IO Guide Pro Tool”, It is only available for Modbus 232 connector in EtherCAT Module.
② Create “New”. (File → Project File → New or Ctrl +N)
③ Scan NA-9186 & IO Modules. (Online → Automatic Scan or Shift + S)




IOGuidePro [Version:1.1.0.1. Build:#0001]
NA-9186 (Port:1. Node:1)
Description NA-9186EtherCAT Network Adapter
Total Power 75 mA (Max. 1500 mA @ 5VDC)
Total Size Width: 70, Height: 99, Length: 69 (mm)
01: ST-1218
02: ST-2328

④ Set values to ST-2328.



Make sure that the normal operation of the product.

6. ETHERCAT BASICS

6.1. EtherCAT Protocol

The EtherCAT protocol uses an officially assigned EtherType inside the Ethernet Frame. The use of this EtherType allows transport of control data directly within the Ethernet frame without redefining the standard Ethernet frame. The frame may consist of several sub-telegrams, each serving a particular memory area of the logical process images that can be up to 4 gigabytes in size. Addressing of the Ethernet terminals can be in any order because the data sequence is independent of the physical order. Broadcast, Multicast and communication between slaves are possible.

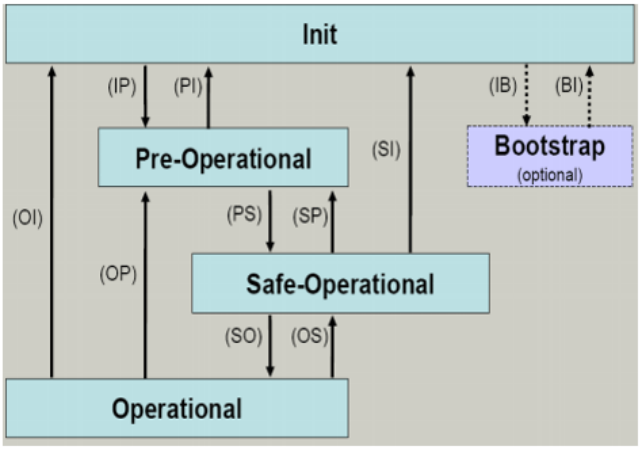
6.2. EtherCAT State Machine

The state of the EtherCAT slave is controlled via the EtherCAT State Machine (ESM). Depending upon the state, different functions are accessible or executable in the EtherCAT slave. Specific commands must be sent by the EtherCAT master to the device in each state, particularly during the bootup of the slave.

A distinction is made between the following states:

- ✓ **Init**
- ✓ **Pre-Operational**
- ✓ **Safe-Operational and**
- ✓ **Operational**
- ✓ **Boot**

The regular state of each EtherCAT slave after bootup is the OP state.



✓ **Init**

After switch-on the EtherCAT slave in the Init state. No mailbox or process data communication is possible. The EtherCAT master initializes sync manager channels 0 and 1 for mailbox communication.

✓ **Pre-Operational (Pre-Op)**

During the transition between Init and Pre-Op the EtherCAT slave checks whether the mailbox was initialized correctly.

In Pre-Op state mailbox communication is possible, but not process data communication. The EtherCAT master initializes the sync manager channels for process data (from sync manager channel 2), the FMMU channels and, if the slave supports configurable mapping, PDO mapping or the sync manager PDO assignment. In this state the settings for the process data transfer and perhaps terminal-specific parameters that may differ from the default settings are also transferred.

✓ **Safe-Operational (Safe-Op)**

During transition between Pre-Op and Safe-Op the EtherCAT slave checks whether the sync manager channels for process data communication and, if required, the distributed clocks settings are correct. Before it acknowledges the change of state, the EtherCAT slave copies current input data into the associated DP-RAM areas of the EtherCAT slave controller (ECSC).
In Safe-Op state mailbox and process data communication is possible, although the slave keeps its outputs in a safe state, while the input data are updated cyclically.

✓ **Operational (Op)**

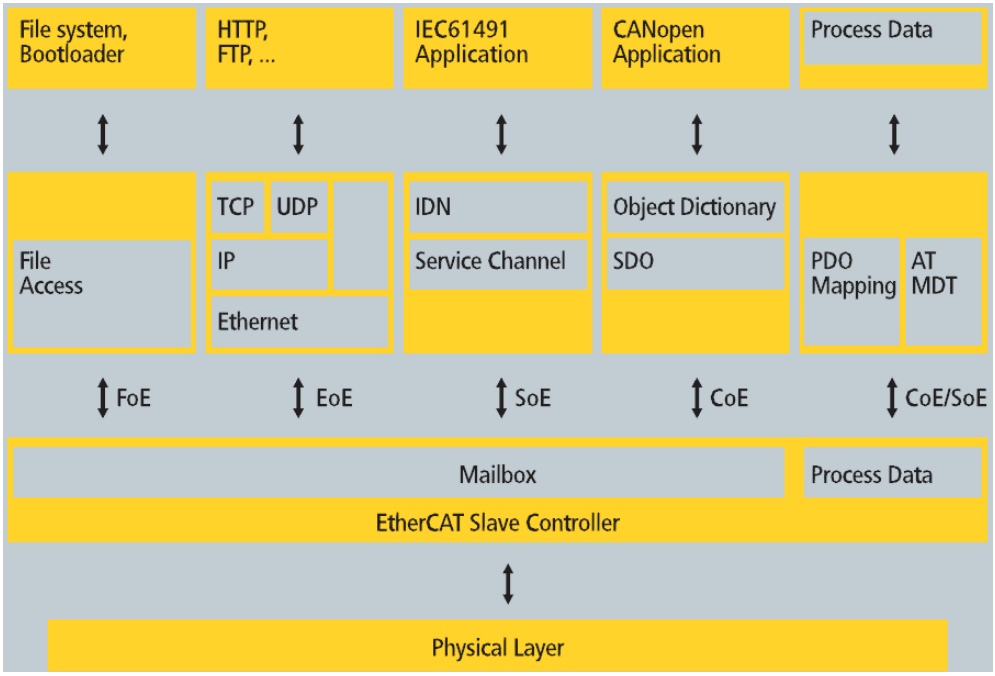
Before the EtherCAT master switches the EtherCAT slave from Safe-Op to Op it must transfer valid output data. In the Op state the slave copies the output data of the masters to its outputs. Process data and mailbox communication is possible.

✓ **Boot**

In the Boot state the slave firmware can be updated. The Boot state can only be reached via the Init state.
In the Boot state mailbox communication via the file access over EtherCAT (FoE) protocol is possible, but no other mailbox communication and no process data communication.

6.3. EtherCAT Mailbox

The device profiles describe the application parameters and the functional behavior of the devices including the device class-specific state machines. For many device classes, fieldbus technology already offers reliable device profiles, for example for I/O devices, drives or valves. Users are familiar with these profiles and the associated parameters and tools. No EtherCAT-specific device profiles have therefore been developed for these device classes. Instead, simple interfaces for existing device profiles are being offered (see Fig. 1).
This greatly assists users and device manufacturers alike during the migration from the existing fieldbus to EtherCAT. At the same time the EtherCAT specification keeps it simple because all the protocols are optional.
The device manufacturer only has to implement the protocol that the device application needs.



<Fig. 1> Several Device Profiles and Protocols can co-exist side by side

- **CAN application layer over EtherCAT (CoE)**

  CANopen® device and application profiles are available for a wide range of device classes and applications, ranging from I/O components, drives, encoders, proportional valves and hydraulic controllers to application profiles for plastic or textile machinery, for example. EtherCAT can provide the same communication mechanisms as the familiar CANopen [1] mechanisms: object dictionary, PDO (process data objects) and SDO (service data objects) – even the network management is comparable. EtherCAT can thus be implemented with minimum effort on devices equipped with CANopen. Large parts of the CANopen firmware can be reused. Objects can optionally be expanded in order to account for the larger bandwidth offered by EtherCAT.

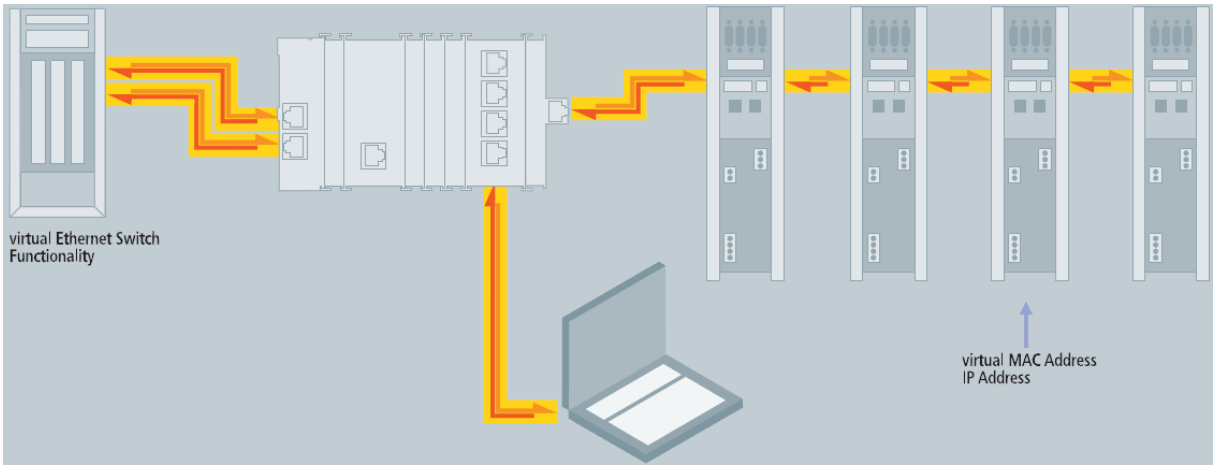
<Refer to 6.4>

- **Servo drive profile according to IEC 61800-7-204(SERCOS) (SoE)**

SERCOS interface™ is acknowledged as a high-performance real-time communication interface, particularly for motion control applications. The SERCOS profile for servo drives and the communication technology are covered by the IEC 61800-7-204 standard. The mapping of this profile to EtherCAT (SoE) is specified in part 304 [2]. The service channel, and therefore access to all parameters and functions residing in the drive, is based on the EtherCAT mailbox.
Here too, the focus is on compatibility with the existing protocol (access to value, attribute, name, units, etc. of the IDNs) and expandability with regard to data length limitation. The process data, with SERCOS in the form of AT and MDT data, are transferred using EtherCAT device protocol mechanisms. The mapping is similar to the SERCOS mapping. The EtherCAT slave state machine can also be mapped easily to the phases of the SERCOS protocol. EtherCAT provides advanced real-time Ethernet technology for this device profile, which is particularly widespread in CNC applications. Optionally, the command position, speed or torque can be transferred. Depending on the implementation, it is even possible to continue using the same configuration tools for the drives.

- **Ethernet over EtherCAT (EoE)**

The EtherCAT technology is not only fully Ethernet-compatible, but also characterized by particular openness “by design”: the protocol tolerates other Ethernet-based services and protocols on the same physical network – usually even with minimum loss of performance. There is no restriction on the type of Ethernet device that can be connected within the EtherCAT segment via a switchport.
The Ethernet frames are tunneled via the EtherCAT protocol, which is the standard approach for internet applications(e.g. VPN, PPPoE (DSL), etc.). The EtherCAT network is fully transparent for the Ethernet device, and the real-time characteristics are not impaired (see Fig. 2).
The master acts like a layer 2 switch that redirects the frames to the respective devices according to the address information. All internet technologies can therefore also be used in the EtherCAT environment: integrated web server, e-mail, FTP transfer, etc.



<Fig. 2> Transparent for all Ethernet Protocols

- **File Access over EtherCAT (FoE)**

  any data structure in the device. Standardized firmware upload to devices is therefore possible, irrespective of whether or not they support TCP/IP.

➢ **Literature**

[1] EN 50325-4: Industrial communications subsystem based on ISO 11898 (CAN) for controller-device interfaces. Part 4: CANopen.

[2] IEC 61800-7-301/304, Adjustable speed electrical power drive systems – Part 7-301: Generic interface and use of profiles for power drive systems – Mapping of profile type 1 to network technologies – Part 7-304: Generic interface and use of profiles for power drive systems – Mapping of profile type 4 to network technologies

6.4. CoE Interface – parameter management in the EtherCAT system

The CiA organization (CAN in Automation) pursues among other things the goal of creating order and exchangeability between devices of the same type by the standardization of device descriptions. For this purpose so-called profiles are defined, which conclusively describe the changeable and unchangeable parameters of a device. Such a parameter encompasses at least the following characteristics:

- Index number – for the unambiguous identification of all parameters. The index number is divided into a main index and a subindex in order to mark and arrange associated parameters.
  - Main index
  - Subindex, offset by a colon ':'
- Official name – in the form of an understandable, self-descriptive text
- Specification of changeability, e.g. whether it can only be read or can also be written
- A value – depending upon the parameter the value can be a text, a number or another parameter index.

➢ **Example) NA-9186 (with ST-1224, ST-2414) CoE directory**

Index		Name	Flags	Value
1000		Device type	RO	0x00001389(5001)
1001		Error register	RO	0x00 (0)
1008		Device name	RO	NA-9186(Crevis)
1009		Hardware version	RO	NA-9186.v1
100A		Software version	RO	1.001
1018:0		Identity	RO	> 5 <
├	1018:01	Vendor ID	RO	0x0000029D (669)
├	1018:02	Product Code	RO	0x39313836 (959526966)
├	1018:03	Revision	RO	0x00010001 (65537)
├	1018:04	Serial Number	RO	0x00000001 (1)
└	1018:05	Release date	RO	0x20120625 (538052133)
10F1:0		Error Settings	RO	> 2 <
├	10F1:01	Local Error Reaction	RO	0x00000000 (0)
└	10F1:02	Sync Error Counter Limit	RO	0x00000004 (4)
1601:0		Slot#2, ST-2414, RxPDO	RO	> 1 <
└	1601:01	SubIndex 001	RO	0x7010:01, 8
1A00:0		Slot#1, ST-1224, TxPDO	RO	> 1 <
└	1A00:01	SubIndex 001	RO	0x6000:01, 8
1A01:0		Slot#2, ST-2414, TxPDO	RO	> 1 <
└	1A01:01	SubIndex	RO	0x6010:01, 8
1C00:0		Sync manager type	RO	> 4 <
├	1C00:01	SubIndex 001	RO	0x01 (1)
├	1C00:02	SubIndex 002	RO	0x02 (2)
├	1C00:03	SubIndex 003	RO	0x03 (3)
└	1C00:04	SubIndex 004	RO	0x04 (4)
1C12:0		RxPDO assign	RO	> 0 <
└	1C12:01	SubIndex 001	RO	0x1601 (5633)
1C13:0		TxPDO assign	RO	> 0 <
├	1C13:01	SubIndex 001	RO	0x1A00 (6656)

└	1C13:02	SubIndex 002	RO	0x1A01 (6657)
6000:0		ST-1224(Input)	RO	> 1 <
└	6000:01	Byte#0	RO P	0x00 (0)
6010:0		ST-2414(Output)	RO	> 1 <
└	6010:01	Byte#0	RO P	0x00 (0)
7010:0		ST-2414(Output)	RO	> 1 <
└	7010:01	Byte#0	RO P	0x00 (0)
8010:0		ST-2414(Parameter)	RO	> 2 <
├	8010:01	Byte#0	RW	0x00 (0)
└	8010:02	Byte#1	RW	0x00 (0)
F000:0		Modular device profile	RO	> 2 <
├	F000:01	Module index distance	RO	0x0010 (16)
└	F000:02	Maximum number of modules	RO	0x0020 (32)
F010:0		Module list	RO	> 2 <
├	F010:01	SubIndex 001	RO	0x00001224 (4644)
└	F010:02	SubIndex 002	RO	0x00002414 (9236)

- Index Range

The relevant ranges for EtherCAT fieldbus users are:

x1000 : This is where fixed identity information for the device is stored, including name, manufacturer, serial number etc., plus information about the current and available process data configurations.
x8000 : This is where the operational and functional parameters for all channels are stored, such as filter settings or output frequency.

Other important ranges are:

x4000 : In some EtherCAT devices the channel parameters are stored here (as an alternative to the x8000 range).
x6000 : Input PDOs ("input" from the perspective of the EtherCAT master)
x7000 : Output PDOs ("output" from the perspective of the EtherCAT master)

6.5. EtherCAT Reference

EtherCAT Reference Documents
http://www.ethercat.org

7. Trouble Shooting

7.1. How to diagnose by LED indicator

LED Status	Cause	Action
All LED turns off	- No power	- Check main power Cable
	- System power is not supplied.	- Contact Sales team and send module for repair.
MOD LED flashes green	- Failure of initialization EEPROM parameter.	- Contact Sales team and send module for repair.
MOD LED flashes red	- Excess of expansion slot - Excess of IO size - Wrong IO composition - Occurrence of EEPROM checksum error	- Use expansion slot up to 32. - Compose that IO total size is not excess. - Check composition I/O Module
MOD LED is red	- Wrong address ID - Occurrence critical error in firmware	- Contact Sales team and send module for repair.
I/O LED turns off	- Failure of realization expansion Module - None expansion Module	- Check connector status both NA series and expansion module.
I/O LED flashes red	Failure of configuration baud rate	- Check communication cable with Master - Check power for master.
	Failure of initialization I/O	- Use expansion slot up to 32. - Compose that IO total size is not excess.
		NA series notice unidentified expansion module ID. Check status of expansion module.
I/O LED is red	Failure of exchanging I/O data	Check status of expansion IO connection.
ERR LED blinking red	Invalid Configuration	Will be updated
ERR LED Double Flashing red	Process Data Watchdog Timeout	Will be updated
ERR LED flashing red	Booting error	Will be updated
ERR LED is red	PDI Watchdog Timeout	Will be updated

7.2. How to diagnose when device couldn't communicate network

Inspection of wrong or omission cable connection.

- Check status of cable connection for each node.
- Check that all color matches between connector and cable.
- Check wire omission.

Terminator resistor

- If terminator resistor is not installed, install terminator resistor
- Check location of terminator resistor

Configuration of Node address

- Check duplication node address.

Configuration of Master

- Check configuration of master
- Check whether to do download or don't
- Check composition is right
  Configuration of communication baud rate
  I/O size
  Configuration of each node

Ground and environment

- Check ground is contacted
- Check environment factor (temperature, humidity, etc) is in less than regular limit

APPENDIX A

A.1. Product List

No.	ST-Number	Description	ID(hex)	Production Status
Digital Input Module				
	ST-1114	4 Points, Sink(Positive), 5Vdc,	41 00 01	Active
	ST-111F	16 Points, Sink(Positive), 5Vdc,	41 01 19	Active
	ST-1124	4 Points, Source(Negative), 5Vdc,	41 00 02	Active
	ST-112F	16 Points, Source(Negative), 5Vdc,	41 01 1A	Active
	ST-1214	4 Points, Sink(Positive), 12V/24Vdc,	41 00 03	Active
	ST-1218	8 Points, Sink(Positive), 12V/24Vdc,	41 00 07	Active
	ST-121F	16 Points, Sink(Positive), 12V/24Vdc,	41 01 13	Active
	ST-1224	4 Points, Source(Negative), 12V/24Vdc,	41 00 04	Active
	ST-1228	8 Points, Source(Negative), 12V/24Vdc,	41 00 08	Active
	ST-122F	16 Points, Source(Negative), 12V/24Vdc,	41 01 14	Active
	ST-1314	4 Points, Sink(Positive), 48Vdc,	41 00 05	Active
	ST-131F	16 Points, Sink(Positive), 48Vdc,	41 01 17	Active
	ST-1324	4 Points, Source(Negative), 48Vdc,	41 00 06	Active
	ST-132F	16 Points, Source(Negative), 48Vdc,	41 01 18	Active
	ST-1804	4 Points, 110Vac,	41 00 09	Active
	ST-1904	4 Points, 220Vac,	41 00 0A	Active
Digital Output Module				
	ST-2114	4 Points TTL Inverting, 5Vdc/20mA,	81 00 0D	Active
	ST-2124	4 Points TTL Non-Inverting, 5Vdc/20mA,	81 00 0F	Active
	ST-221F	16 Points Sink(Negative Logic), 24Vdc/0.5A,	81 01 15	Active
	ST-222F	16 Points Source(Positive Logic), 24Vdc/0.5A,	81 01 16	Active
	ST-2314	4 Points Sink(Negative Logic), 24Vdc/0.5A,	81 00 0E	Active
	ST-2318	8 Points Sink(Negative Logic), 24Vdc/0.5A,	81 00 11	Active
	ST-2324	4 Points Source(Positive Logic), 24Vdc/0.5A,	81 00 10	Active
	ST-2328	8 Points Source(Positive Logic), 24Vdc/0.5A,	81 00 12	Active
	ST-2414	4 Points Sink(Negative Logic), 24Vdc/0.5A, Diagnostics	81 00 08	Active
	ST-2424	4 Points Source(Positive Logic),24Vdc/0.5A, Diagnostics	C1 00 00 38	Active
	ST-2514	4 Points Sink(Negative Logic), 24Vdc/2A, Diagnostics	C1 00 00 35	Active
	ST-2524	4 Points Source(Positive Logic), 24Vdc/2A, Diagnostics	C1 00 00 36	Active
	ST-2614	4 Points Sink(Negative Logic), 24Vdc/2A,	81 00 3B	Active
	ST-2624	4 Points Source(Positive Logic), 24Vdc/2A,	81 00 3C	Active
	ST-2742	2 Points, 230Vac/2A, 24Vdc/2A, Relay	81 00 0B	Active
	ST-2744	4 Points, 230Vac/2A, 24Vdc/2A, Relay	81 00 51	Active
	ST-2748	8 Points, 230Vac/2A, 24Vdc/2A, Relay	81 00 50	Active

	ST-2792	2 Points, 230Vac/2A, 24Vdc/2A, Relay, Manual/Auto	C1 00 01 BE	Active
	ST-2852	2 Points, 12~125Vac/0.5A, Triac	81 00 0C	Active
	ST-2924	4 Points, 24Vac/2A, 24Vdc/2A, 4 Points/4COM	81 00 C0	NEW
	ST-2944	4 Points, 24Vac/2A, 24Vdc/2A, 1 Points/1COM	81 00 C1	NEW
	ST-2734	4 Points, 24~220Vac,dc/0.5A, 1 Points/1COM	81 00 C2	NEW
Analog Input Module				
	ST-3114	4 Channels, Current, 0~20mA, 12bit	41 43 1C	Active
	ST-3118	8 Channels, Current, 0~20mA, 12bit	41 47 82	Active
	ST-3134	4 Channels, Current, 0~20mA, 14bit	41 43 1E	Active
	ST-3214	4 Channels, Current, 4~20mA, 12bit	41 43 1D	Active
	ST-3218	8 Channels, Current, 4~20mA, 12bit	41 47 83	Active
	ST-3234	4 Channels, Current, 4~20mA, 14bit	41 43 1F	Active
	ST-3274	4 Channels, Current, 4~20mA, 12bit, Sensor Connector	41 43 A3	Active
	ST-3424	4 Channels, Voltage, 0~10Vdc, 12bit	41 43 20	Active
	ST-3428	8 Channels, Voltage, 0~10Vdc, 12bit	41 47 22	Active
	ST-3444	4 Channels, Voltage, 0~10Vdc, 14bit	41 43 22	Active
	ST-3474	4 Channels, Voltage, 0~10Vdc, 12bit, Sensor Connector	41 43 A0	Active
	ST-3524	4 Channels, Voltage, -10Vdc~10Vdc, 12bit	41 43 21	Active
	ST-3544	4 Channels, Voltage, -10Vdc~10Vdc, 14bit	41 43 23	Active
	ST-3624	4 Channels, Voltage, 0~5Vdc, 12bit	41 43 24	Active
	ST-3644	4 Channels, Voltage, 0~5Vdc, 14bit	41 43 25	Active
	ST-3702	2 Channels, RTD, Status	41 41 28	Active
	ST-3704	4 Channels, RTD, Status	41 43 64	Active
	ST-3708	8 Channels, RTD, Status	41 47 65	Active
	ST-3802	2 Channels, TC	41 41 2A	Active
	ST-3804	4 Channels, TC	41 43 66	Active
	ST-3808	8 Channels, TC	41 47 67	Active
Analog Output Module				
	ST-4112	2 Channels, Current, 0~20mA, 12bit	81 41 2C	Active
	ST-4114	4 Channels, Current, 0~20mA, 12bit	81 43 6D	Active
	ST-4212	2 Channels, Current, 4~20mA, 12bit	81 41 2D	Active
	ST-4214	4 Channels, Current, 4~20mA, 12bit	81 43 6E	Active
	ST-4274	4 Channels, Current, 4~20mA, 12bit, Sensor Connector	81 43 B3	Active
	ST-4422	2 Channels, Voltage, 0~10Vdc, 12bit	81 41 2E	Active
	ST-4424	4 Channels, Voltage, 0~10Vdc, 12bit	81 43 6A	Active
	ST-4474	4 Channels, Voltage, 0~10Vdc, 12bit, Sensor Connector	81 43 B0	Active
	ST-4491	1 Channel, Voltage, 0~10Vdc, 12bit, Manual Type	C1 40 41 BF	Active
	ST-4522	2 Channels, Voltage, -10~10Vdc, 12bit	81 41 2F	Active
	ST-4622	2 Channels, Voltage, 0~5Vdc, 12bit	81 41 30	Active
	ST-4911	1 Channel, Current, 0~1A, 12bit	81 40 31	Active

Special Module				
	ST-5101	1 Channel, High Speed Counter, 5V Input	C1 01 05 34	Active
	ST-5111	1 Channel, High Speed Counter, 24V Input	C1 01 05 39	Active
	ST-5112	2 Channel, High Speed Counter, 24V Sink Input	C1 01 07 4D	Active
	ST-5114	4 Channel, High Speed Counter, 24V Sink Input	C1 03 0F 4C	Active
	ST-5211	RS232 Communication, 1Channel, RTS/CTS Flow Control	C1 05 05 42	Active
	ST-5212	RS232 Communication, 2Channel	C1 0B 0B 43	Active
	ST-5221	RS422 Communication, 1Channel	C1 05 05 44	Active
	ST-5231	RS485 Communication, 1Channel	C1 05 05 45	Active
	ST-5232	RS485 Communication, 2Channel	C1 0B 0B 46	Active
	ST-5351	SSI Interface 1CH	C1 01 09 9E	Active
	ST-5422	2 CH PWM output, 1.5A/24Vdc, source	C1 05 01 57	Active
	ST-5442	2 CH PWM output, 0.5A/24Vdc, source	C1 05 01 56	Active
	ST-5444	4 CH PWM output, 0.5A/24Vdc, source	C1 0B 03 54	Active
	ST-5641	1 CH Pulse output, 0.5A/24Vdc, source	C1 05 03 92	Active
	ST-5642	2 CH Pulse output, 0.5A/24Vdc, source	C1 09 07 90	Active
	ST-5651	1 CH Pulse output, RS422	C1 05 03 98	Active
Power Module				
	ST-7408	8 Channels, Shield, ID Type	02 00 E4	Active
	ST-7508	8 Channels, Common, 0Vdc, ID Type	02 00 E5	Active
	ST-7511	1 Channel, Expansion Power, Input 24Vdc, Output 1.0A/5Vdc, ID Type	02 00 E0	Active
	ST-7518	8 Channels, Common, 24Vdc, ID Type	02 00 E6	Active
	ST-7588	8 Channels, Common, 0Vdc and 24Vdc, ID Type	02 00 E7	Active
	ST-7641	1 Channel, Field Distributor, 5Vdc~48Vdc, 110Vac~220Vac, ID Type	02 00 E2	Active

A.2. Glossary

- System Power: The power for starting up CPU.
- Field Power: The power for input and output line.
- Terminator Resistor: Resistor for prevention reflected wave.
- EDS: Electronic Data Sheet.
- sinking: The method of input and output what device does not have power source.
- sourcing: The method of input and output what device have power source.